Lessons Learned from Long-Term Biological Monitoring Programs

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Biographical Sketches of Authors

Mark Peterson is a Research and Development (R&D) Staff Member in the Environmental Sciences Division of Oak Ridge National Laboratory (ORNL). Since joining ORNL in 1988, he has been the principal scientist and project manager of numerous projects dealing with the monitoring and assessment of contaminants in aquatic biota at various DOE and DoD sites. He has authored over 70 open literature publications and technical reports dealing with contaminant uptake in aquatic organisms, environmental impact assessment, wetland evaluation, and human and ecological risk issues.

Coauthors and fellow ORNL research staff members James Loar, Mark Greeley Jr., Michael Ryon, John Smith, and George Southworth all work with Mark in leading various components of long-term biological monitoring programs. James Loar has an ecological background and is the overall program manager and group leader. Mark Greeley is the principal investigator for toxicity testing studies, while Michael Ryon and John Smith are the principal investigators for fish and benthic macroinvertebrates tasks respectively. George is an environmental chemist and toxicologist who has particular interests in fate and transport processes.

Abstract

Biomonitoring programs developed in the mid-1980s to assess compliance of DOE facilities with Tennessee water quality regulations have continued until the present day. The aquatic environment near these facilities has been subjected to multiple disturbances, including effluent discharges, sediment/soil contamination, groundwater contamination, and habitat alterations. The long-term monitoring programs have provided many benefits in addition to documenting regulatory compliance. Initial monitoring studies provided detailed site characterizations to identify sources, evaluate potential causes and range of impacts, and determine relative risks to humans and the environment. Especially useful were monitoring methods reflecting short time scales and near-field effects, such as water chemistry, biomarker, and toxicity monitoring. With a better understanding of these impacts, the number of sampling sites was reduced to major source areas and watershed exit points, with the objective of evaluating stream recovery and the effectiveness of remedial actions. Bioaccumulation monitoring and instream community surveys were particularly useful for these temporal evaluations, because relatively long-lived, resident organisms integrate the combined effects of multiple sources/impacts that may occur over time scales of months or years. Lessons learned from these long-term biomonitoring programs include the importance of using (1) multiple and complementary monitoring tasks, (2) quantitative measures that adequately account for sample variability, (3) meaningful sampling locations within the range of site exposure and effects, (4) continuous, same-season monitoring, (5) appropriate and multiple reference sites to measure impacts, and (6) comparable and consistent methodologies across time and space.